DEVELOPMENT OF AUTONOMOUS UNDERWATER VEHICLE

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ABSTRACT

In the new era of technology, unmanned vehicles was created to help human explore the area that are can't reached by human kind. Robotic can be related to the most of invention which can reduce human's work using specialized equipment and devices that control and perform the particular tasks. For Underwater exploration, Underwater Vehicle without human are created to help human do research. Most of installation pipeline underwater can be dangerous area. The purpose invention of Autonomous Underwater Vehicle (AUV) can bring human to reach the dangerous areas. AUV stands for Autonomous Underwater Vehicle. Autonomous Underwater Vehicle (AUV) is unmanned or robotic vehicles that are using some technology to bring new capabilities to work in the subsea environment. Nowadays, this technology of Autonomous Underwater Vehicle (AUV) has upgrade their abilities which are can explore into deep seas. To reach that, a lot of investments are needed. This project will be focus on development of Autonomous Underwater Vehicles which are performing limited capabilities. AUV uses propellers to move the vehicle along vertical and horizontal axis that automatic operate based on the programming coding. The main objectives of the construction of the AUV are to replace human to do tasks underwater. In this project, the scope of the study focused on the mechanical design that water prove and design of the thruster using the DC motor and propeller.

ABSTRAK

Dalam era baru teknologi, kenderaan tanpa manusia dihasilkan untuk membantu manusia bagi membolehkan kita meneroka ke kawasan yang tidak mampu dicapai oleh manusia.Robotik boleh dikaitkan dengan penghasilan alat-alat yang mampu meringankan beban manusia dengan menggunakan peralatan yang istimewa dan juga peranti yang boleh mengawal kerja. Untuk eksplorasi di dalam air,kenderaan bawah air (AUV) dihasilkan bagi membantu manusia menjalankan kajian.Kebanyakkan pemasangan paip di dalam air terdedah kepada bahaya.Oleh itu,penciptaan kenderaan bawah air (AUV) membolehkan manusia melakukan kerja di kawasan yang terdedah kepada bahaya.Kenderaan bawah air adalah kenderaan tanpa manusia yang menggunakan teknologi untuk memberi kebolehan yang baru dalam melakukan kerja-kerja di dalam laut.Sekarang ini,teknologi kenderaan dalam air telah diubahsuai akan kebolehannya untuk melakukan eksplorasi di laut dalam.Untuk merealisasikan impian itu,banyak modal perlu dilaburkan.Projek ini memfokuskan kepada penghasilan kenderaan dalam air yang beroperasi secara terhad.Kenderaan dalam air menggunakan sepenuhnya daya tolakan dan daya angkat yang membolehkan ia bergerak ke hadapan,belakang,pusing arah jam dan juga pusingan lawan jam.Objektif utama penghasilan kenderaan dalam air adalah untuk menggantikan tempat manusia untuk melakukan kerja-kerja di dalam air.Projek ini menerangkan lakaran mekanikal,penghasilan motor yang kalis air dengan menggunakan DC motor dan bilah kipas bot.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Human capabilities are limited into deep sea. To overcome this problem, many inventor have create a thousand creation to discover the underwater world. Besides, under deep sea are dangerous and sometimes can cause death. Due to the limitation, human are difficult to explore under deep sea which is the untouchable area. Thus, unmanned underwater vehicle have created.With unmanned task, this underwater vehicle can explore and discover the underwater world and reduce the capability of human. This underwater vehicle generally can be divided into two major field, Autonomous Underwater Vehicles (AUV) and Remotely Operate Vehicle (ROV). Recently, underwater vehicle have been used in limited number of task. With further research and development, underwater vehicle can reduces the limitation and increase the capability to do more tasks. Today, most of Autonomous Underwater Vehicles (AUV) can been seen in military field, oiled and gas industry and some of the expedition to explorer under the deep sea. However, this project will be focus on Autonomous Underwater Vehicles (AUV).

1.2 PROJECT OBJECTIVE

The objectives of the project are:

a) To develop underwater vehicle that able to move underwater.
b) To develop underwater vehicle that able to float, submerge, rotate left and right in the water.
c) To design the physical structure, electronic circuit and control of the vehicle.

1.3 PROJECT SCOPE

The scopes of the project are as follow:

a) Literature study on the general characteristic of AUV.
b) In depth study of mechanical design and electronic circuit.
c) Design the waterproof propeller.
d) Increase the downward force acting to reduce the buoyancy force.
e) In depth study on Buoyancy principle.
f) Performance of the propeller underwater through water pressure.

1.4 PROBLEM STATEMENT

Deep underwater exploration is one of dangerous task due to limited of human capabilities. If human can discover the underwater, many discoveries could get and learned with it. So, the underwater vehicle has been designed to overcome that problem.

1.5 EXPECTED OUTCOMED

The expected outcomes are as follow:

a) In the end of this project, AUV can operate underwater with forward and backward movements rotate left and right with basic 3D design that is develop using computer software called Google Sketch Up.

b) It will stabilized floating in water and smooth submerging underwater.

CHAPTER 2

Literature Review

2.1 HULL DESIGN

An Autonomous Underwater Vehicle (AUV) hull must be able to protect its components in dry, watertight environment. The hull must allow components to be easily accessible and maintainable, as well as allowing for modularity in case of future changes or additions [1]. Being under the water are the major problems through AUV. Thus,designing the hull, it must be consider that there is no leak in each part of the body of AUV. The electrical part must be place properly to avoid changing the component once it wet and being short circuit. To make sure the AUV movement underwater flow in smooth, the Hydrodynamic concept must be design. Hydrodynamic is the concept of the dynamic fluids in motion. However, the hull design helps the AUV smooth in the water besides support by the propeller.

2.1.1 Material Body

The Material Body are the important part of design.The material must choose wisely in order to make the body of Autonomous Underwater Vehicle (AUV) in high durablelity, strong and light. In this project, the body of the Autonomous Underwater(AUV) is build base on those criteria. Polyvinyl chloride (PVC) are the best match for those criteria. The principal goals of AUV design effort is to produce a vehicle that is small, inexpensive, easy to deploy, and yet fully functional [2].

2.1.1.1 Polyvinyl chloride (PVC)

PVC is a widely used thermoplastic polymer. In terms of revenue generated, it is one of the most valuable products of the chemical industry. Overall, over 50% of PVC manufactured is used in construction. As a building material, PVC is cheap, durable, and easy to assemble. Regardless of claims that PVC production negatively affects the natural environment and human health, it is still widely used.

The same criteria as hard plastic, it is used as vinyl siding, , piping, plumbing and conduit fixtures. The material is often used in Plastic Pressure Pipe Systems for pipelines in the water and sewer industries because of its inexpensive nature and flexibility. PVC pipe plumbing is typically white, which is commonly available in grey as well as white. In this form, it is used in clothing and upholstery, and to make flexible hoses and tubing, flooring, to roofing membranes, and electrical cable insulation.

2.1.2 Hydrodynamic

Hydrodynamic is the concept of the dynamic fluids in motion. Basically ,the theory are same as aerodynamic theory. The motion of the Autonomous Underwater Vehicle gives rise to a pressure distribution over its surfaces, which should be integrated to obtain the hydrodynamic effect of the interaction with the water. The movement of AUV in the water must be smooth in order to make perfect path of the AUV to its destination.The smoothly of AUV across its path the better efficient to the propulsion system.Figure show the water flow through AUV body.

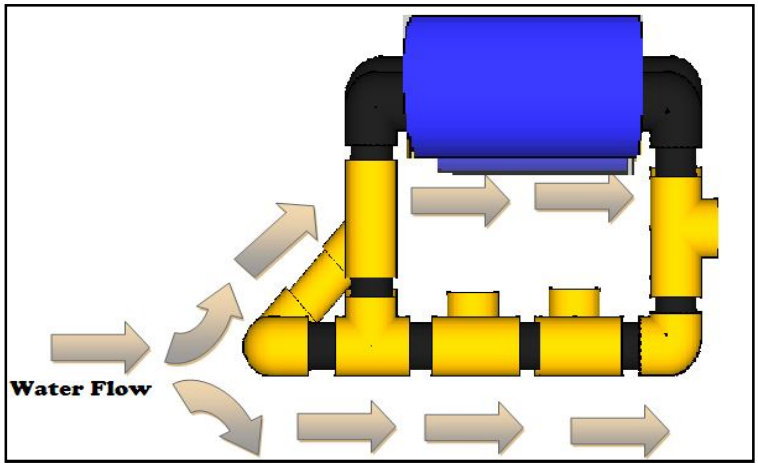

Figure 2.0 : Water flow through AUV body.

2.2 Propulsion

All Autonomous Underwater Vehicles (AUV) required some sort of propulsion and is usually one of the main sources of power consumption. Most of AUV use motors

for propulsion due to the scarcity and cost of alternative systems [2].The location of the motor affect which degrees of freedom can be controlled [3]. In this project, two motors are required to do the forward and backward motion and the other two for submerging. To make sure AUV travels in smooth underwater and have limited energy supply, it must travel at a speed that does not draw to much power. At a same time, this AUV does not take too long to complete its mission. Hence, obtaining the ideal speed becomes are the best solution for this problems.

2.2.1 Thruster design

Thruster of Autonomous Underwater Vehicle (AUV) are currently related to the propulsion system.Propulsion is define as movement caused by a force[3].The force acting by the truster can make the AUV forward ,backward rotate left and right position.The waterproof truster design can be devided into several part.Thruster consist DC motor, coupling shaft and propeller.The body of the thruster is made by PVC.Thruster are need to be waterproof to avoid short circuit to the main controller board of AUV.

2.2.1.1 DC Motor

In this project,propulsion system use two DC motor. DC motor is define as simple electric motor that uses electricity and a magnetic field to produce torque,.In other word it has ability to turns the motor.

2.2.1.2 Principle operation of DC Motor

In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field. When this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.Figure 2.1 indicate the operation inside the DC motor.

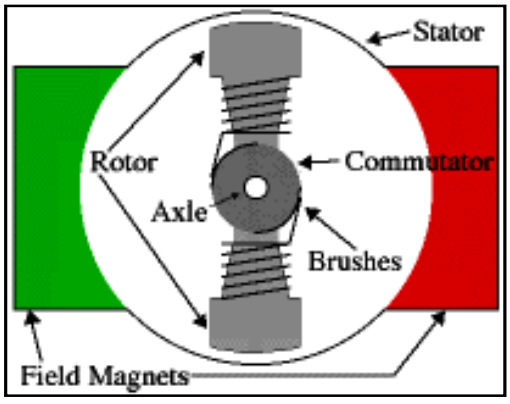

Figure 2.1 : Operation inside the DC motor.

Every DC motor has six basic parts which are axle, rotor ,stator, commutator, field magnet(s), and brushes. In most common DC motors, the external magnetic field is produced by high-strength permanent magnets. The stator is the stationary part of the motor. This includes the motor casing, as well as two or more permanent magnet pole pieces. The rotor rotate with respect to the stator. The rotor consists of windings, the windings being electrically connected to the commutator.

The geometry of the brushes, commutator contacts, and rotor windings are such that when power is applied, the polarities of the energized winding and the stator magnets are misaligned, and the rotor will rotate until it is almost aligned with the stator's field magnets. As the rotor reaches alignment, the brushes move to the next commutator contacts, and energize the next winding. In real life, though, DC motors will always have more than two poles (three is a very common number). In particular, this avoids "dead spots" in the commutator. Meanwhile, with a two-pole motor, there is a moment where the commutator shorts out the power supply. This would be bad for the power supply, waste energy, and damage motor components as well.

2.2.1.3 12 volt DC Motor

AUV used 12 volt DC Motor and it was produce in China.This 12 volt DC motor arer use in many application such as in household appliances, including hair cutter machines, massagers, toy models, electrical toys, remote controllers, DVD and VCD players, and printers.Figure 3 show the specification of DC motor.

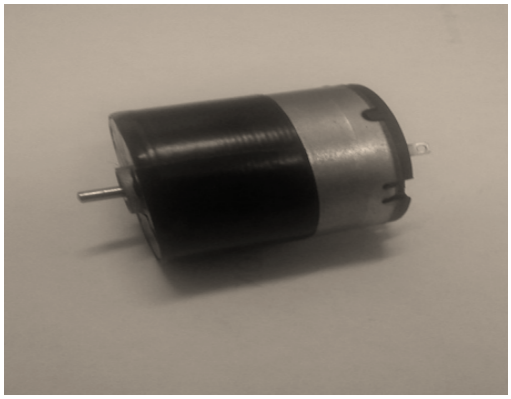

Figure 2.2: Specification of DC motor.

Table 1: 12 Volt DC Motor

Product Name	DC Motor
Model Number	260, 360, 500, BL00 series motor
Place of Origin	China
Power	1.5 - 12V DC
Free load	a) Speed: 6,000 - 20,000rpm b) Current: 0.12 - 0.3A
At max. efficiency	a) Speed: 5,000 - 18,000rpm b) Current: 0.2 - 0.6A c) Torque: 15 - 50gf-cm d) Power: 1.0 - 5.0 watts

2.2.2 Propeller

A propeller is a device consisting of a set of two or more twisted, airfoil-shaped blades mounted around a shaft and spun to provide propulsion of a vehicle through water or air, or to cause fluid flow, as in a pump. The lift generated by the spinning blades provides the force that propels the vehicle or the fluidthe lift does not have to result in an actual upward force.Its direction is simply parallel to the rotating shaft.Figure 2.3 show the propeller that mount to coupling shaft.

Figure 2.3: Propeller mounting to coupling shaft.

2.2.2.1 Marine Propeller Terminology

There are a variety of terms used to describe propeller characteristics as well as performance attributes. It is important that to learn and have a good understanding of them, as detailed here. In this thesis,several of marine propeller terminology will be discuss which are diameter, pitch and the number of blades.

2.2.2.1.1 Diameter

Diameter is the distance across the circle made by the blade tips as the propeller rotates. Diameter is determined primarily by the RPM at which the propeller will be turning and the amount of power that will be delivered to the propeller through the shafts and gears. The degree to which the propeller may operate in a partially surfaced condition, as well as the intended forward velocity, will also play a role in determining the most desirable diameter.

Within a given propeller line, the diameter usually increases for propellers used on slower boats and decreases for faster boats. If all other variables remain constant, diameter will increases as power increases, diameter will increase as propeller RPM decreases, and diameter should increases as propeller surfacing increases.

2.2.2.1.2 Pitch

Pitch is the distance that a propeller would move in one revolution if it were moving through a soft solid, like a screw in wood. Pitch is measured on the face of the blade.A number of factors can cause the actual pitch of a propeller to vary from the advertised pitch stamped on it. Minor distortion may have occurred during the casting and cooling process. Adjustments or modifications may have been made by propeller repair stations. And finally, undetected damage may have altered the pitch.

There are two common types of pitch which areconstant (flat pitch) and progressive pitch. Constant pitch means the pitch is the same at all points from the leading edge to the trailing edge. Progressive pitch starts low at the leading edge and

progressively increases to the trailing edge. The pitch number assigned is the average pitch over the entire blade. Progressive pitch improves performance when forward and rotational speed are high and the propeller is operating high enough to break the water surface. It is commonly used on mid- to high-horsepower Mercury propellers.

Pitch is rather like another set of gears. For a given engine that wants to run at a given RPM, the faster the boat can go, the higher the pitch you need. If you select too low a pitch, the engine RPM will run too high, putting an undesirable higher stress on many moving parts. It may have a great acceleration butthe top speed will probably suffer and propeller efficiency will definitely suffer. Selecting too high a pitch will force the engine to lug at a low RPM which is generally at a higher torque level and can be very damaging to the engine. Top speed may not suffer too much, but acceleration will be seriously reduced.

2.2.2.1.3 Number Of Blades

A single-blade propellerwould be the most efficient - if the vibration could be tolerated. So, to get an acceptable level of balance with much less vibration, a two-bladed propeller, practically speaking, is the most efficient. As blades are added, efficiency decreases, but so does the vibration level. Most propellers are made with three blades as a compromise for vibration, convenient size, efficiency, and cost.

The efficiency difference between a two- and a three-bladed propeller is considered less significant than the vibrational difference. Nearly all racing propellers are presently either three- or four-bladed. In recent years, with the growing frequency of propellers being run at an increased height four- and five- bladed props havebecome more popular. They suppress the higher level of vibration and improve acceleration by